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Stack et al.

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(54) **SWITCH CELL**

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H01H 9/26 (2006.01)
H01H 15/00 (2006.01)

(52) **U.S. Cl.** ..... **200/553**; 200/5 R; 200/16 R; 200/547

(58) **Field of Classification Search** ..... 200/5 R, 200/6 R–6 BA, 16 R, 16 A, 18, 547, 551, 200/553

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,243,156	A *	9/1993	Shirasaka	200/5 R
5,844,182	A *	12/1998	Hirano et al.	200/5 R
6,252,183	B1 *	6/2001	Shirai	200/5 R
6,262,379	B1 *	7/2001	Tajima	200/5 R
6,515,241	B1 *	2/2003	Saiki	200/5 R
6,743,997	B1 *	6/2004	Schmidt et al.	200/553
6,841,751	B1 *	1/2005	Sasaki et al.	200/553

* cited by examiner

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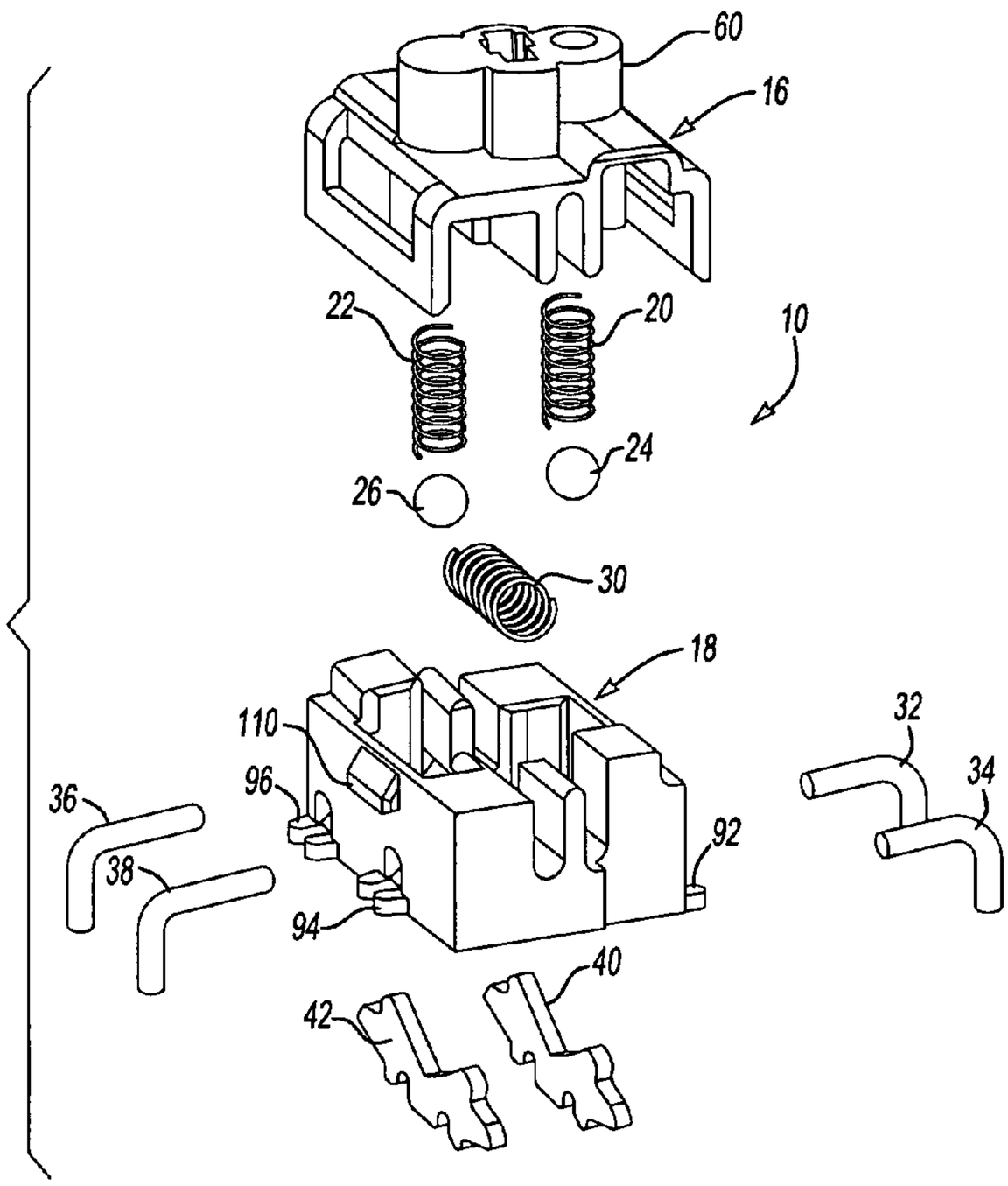
(57) **ABSTRACT**

A switch cell for use in opening and closing electrical connections, a multiple cell switch having multiple switch cells, and a method of assembling the same. The switch cell preferably includes one or more contactors in a base and an actuator slidable engaged to the base for controlling electrical connectivity by controlling movement of the contactors.

20 Claims, 4 Drawing Sheets



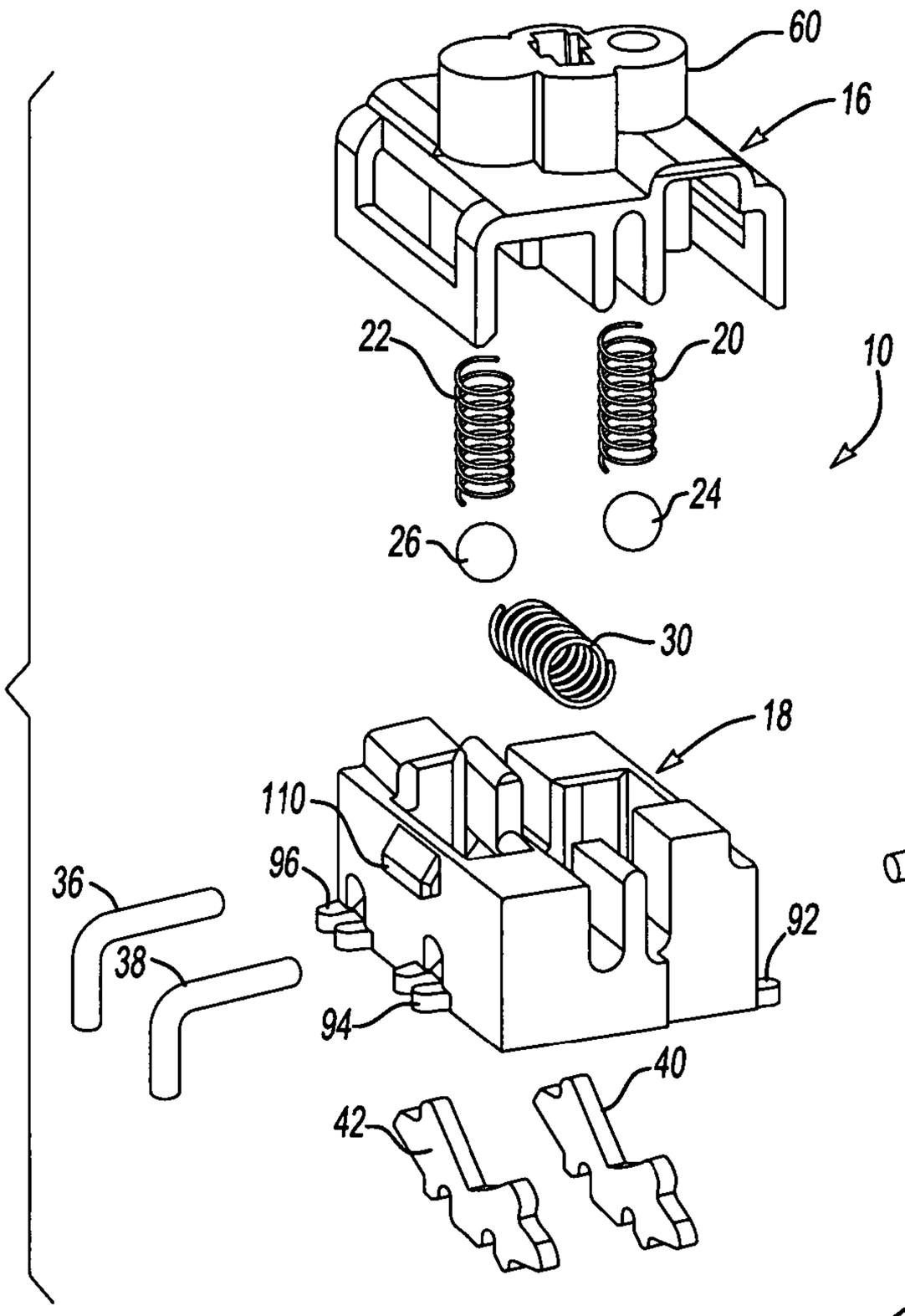

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Fig-1

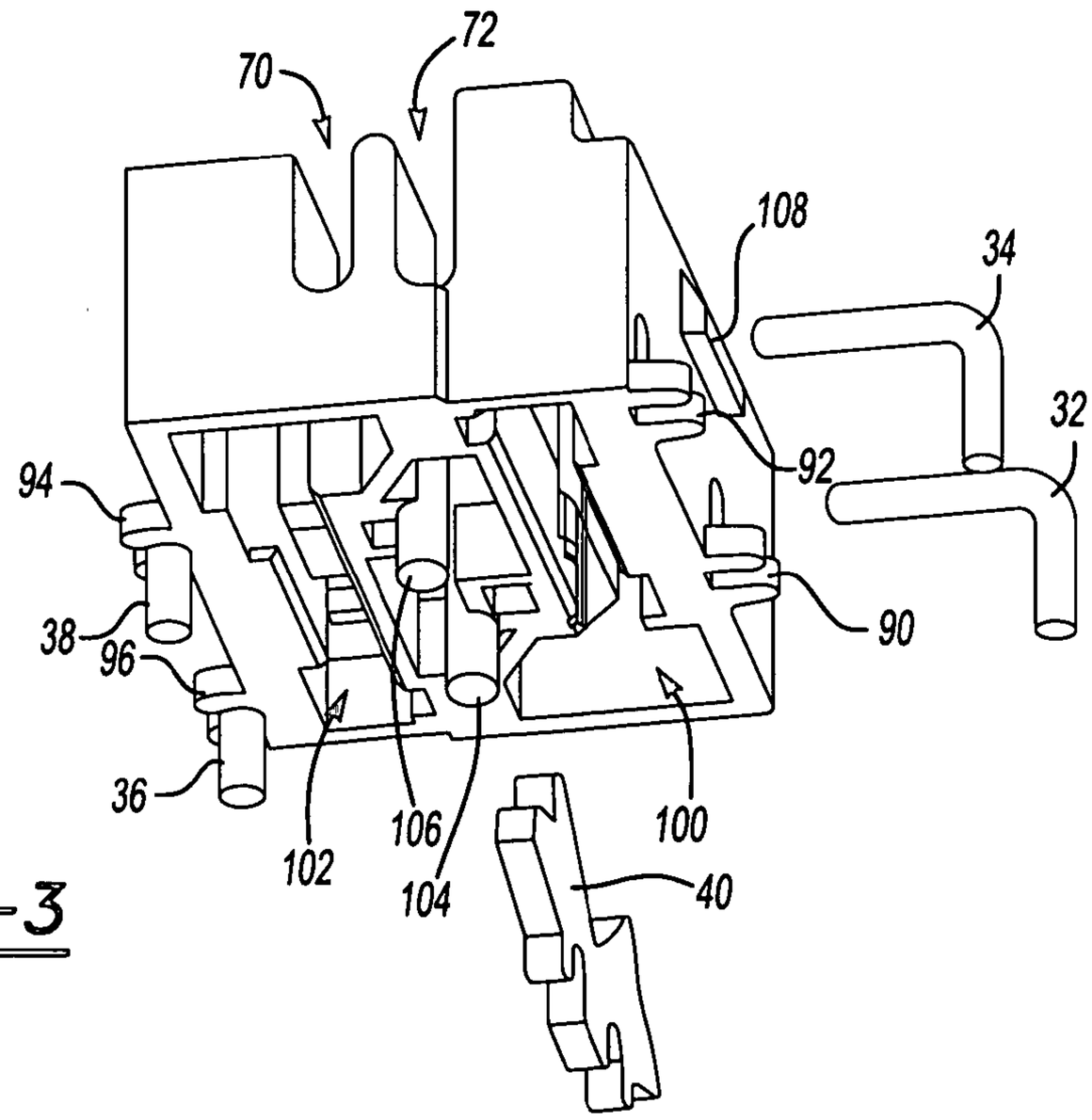
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Fig-3

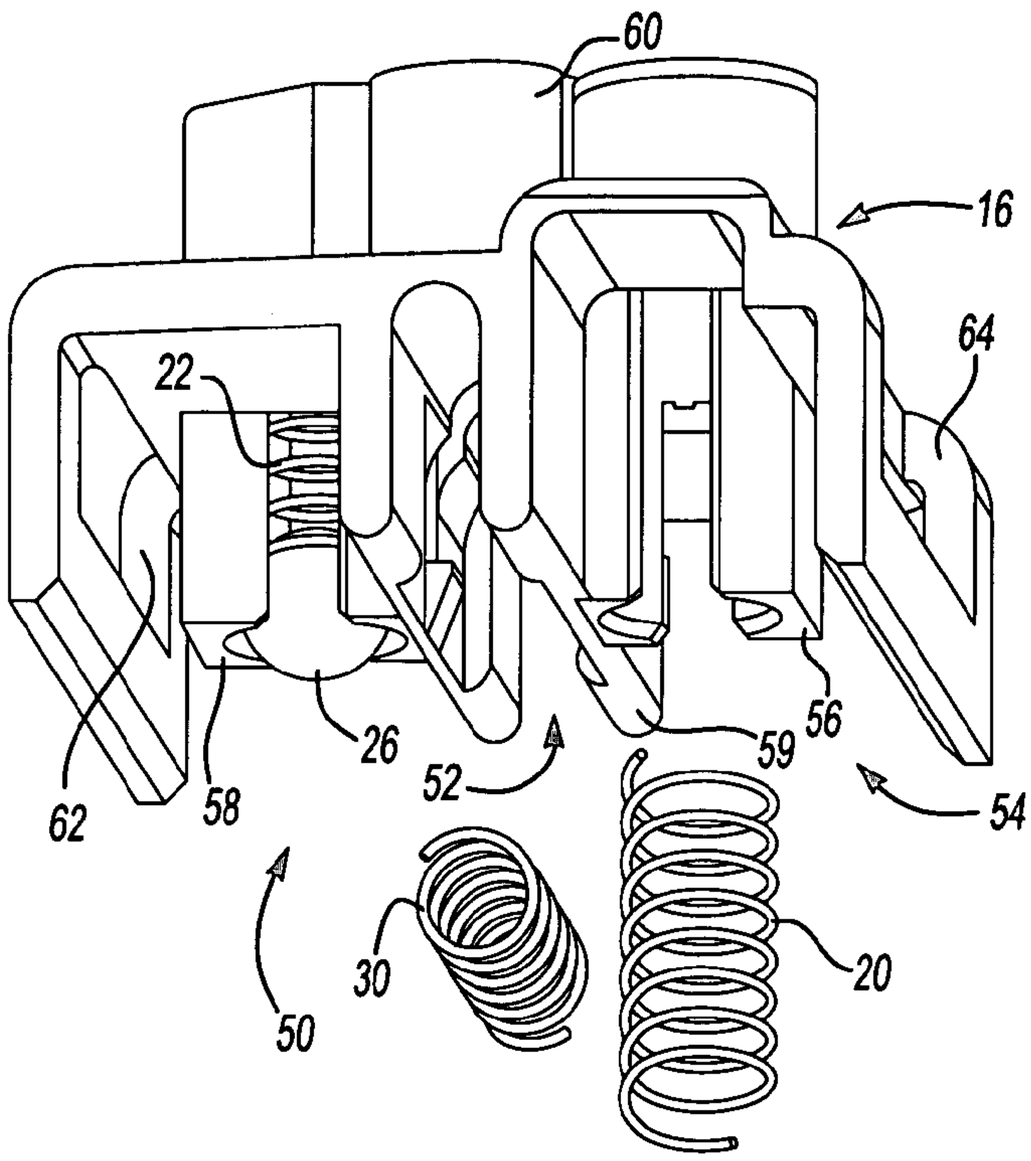
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Fig-2

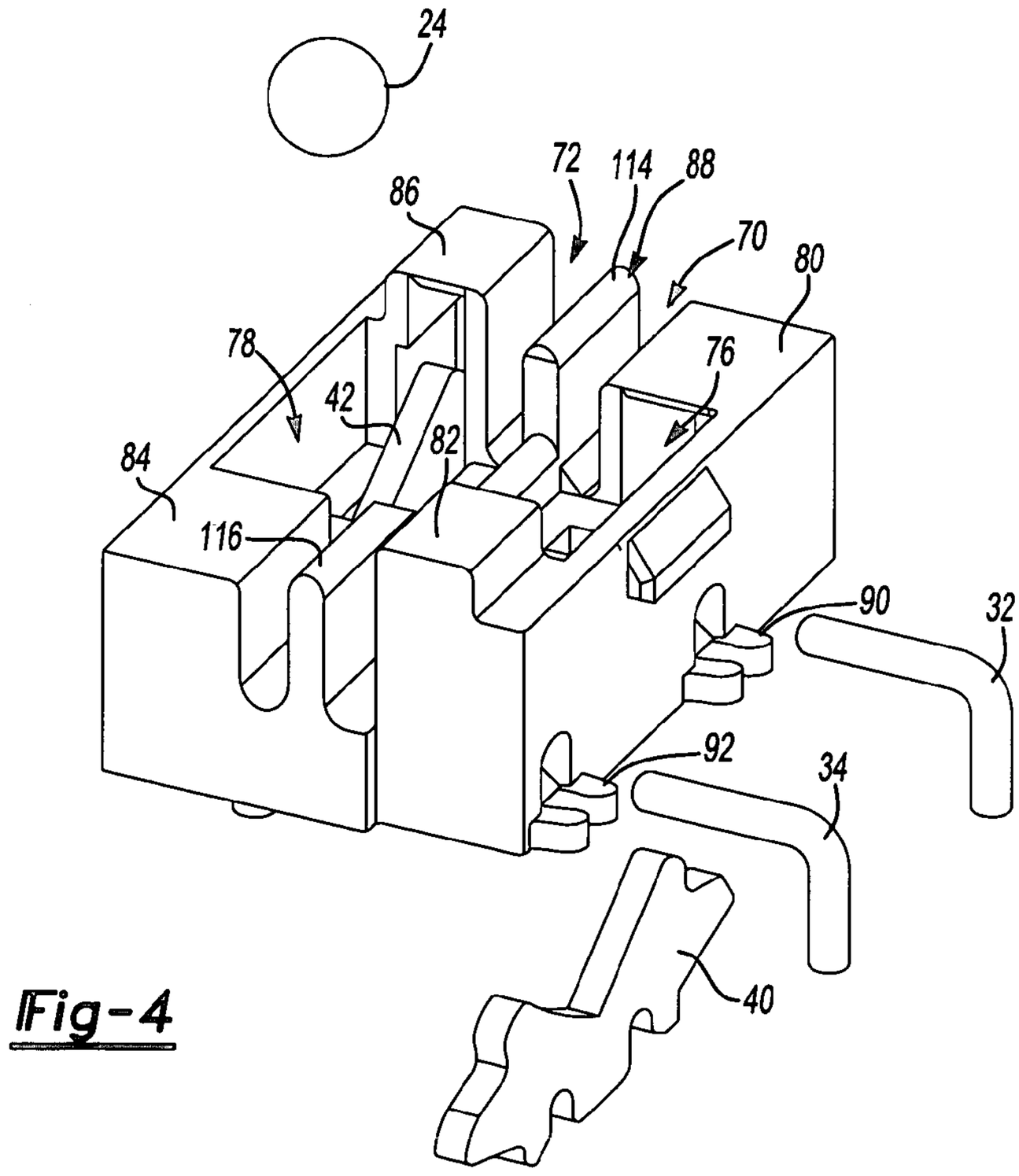
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Fig-4

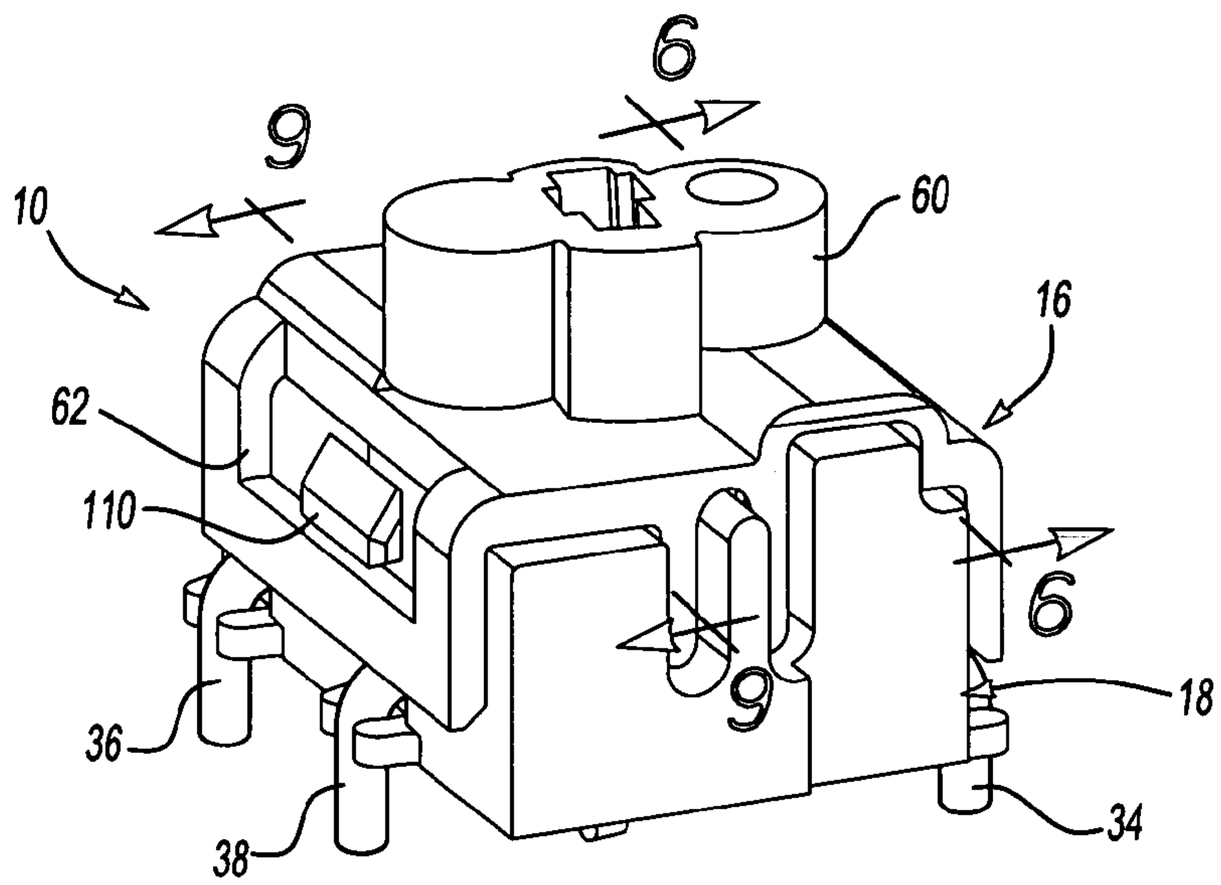

Fig-5

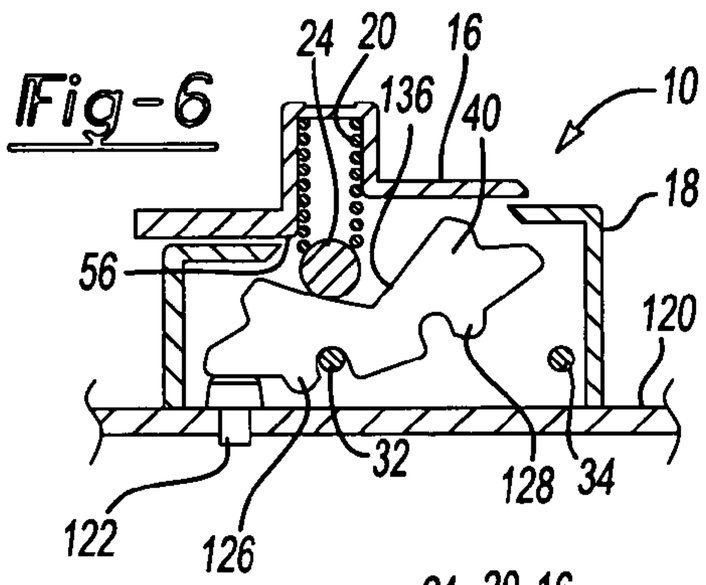

Fig-6

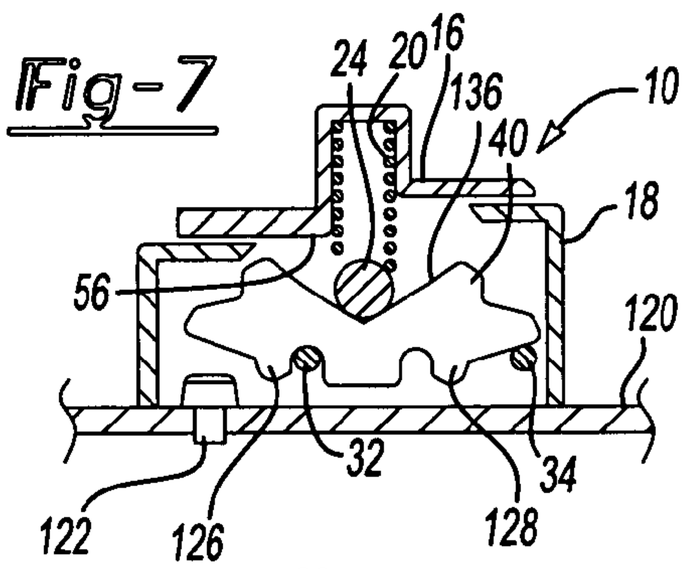

Fig-7

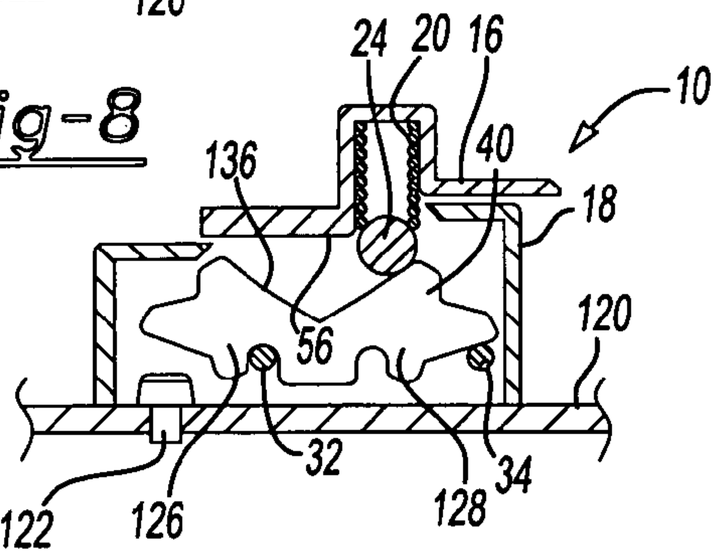

Fig-8

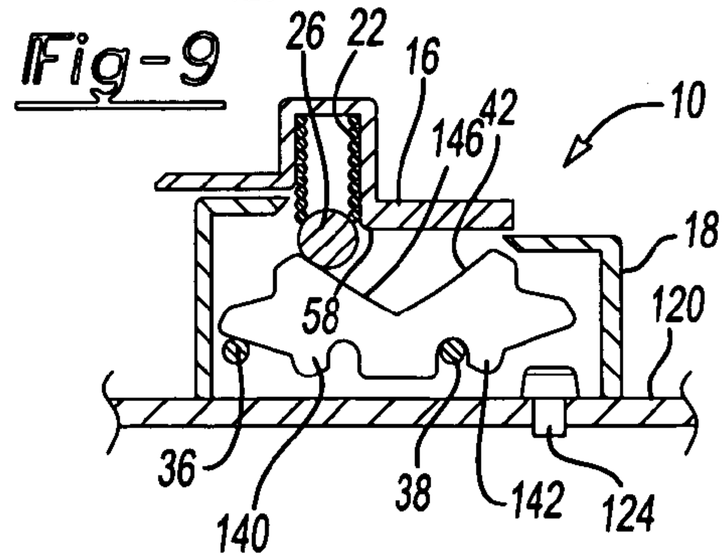

Fig-9

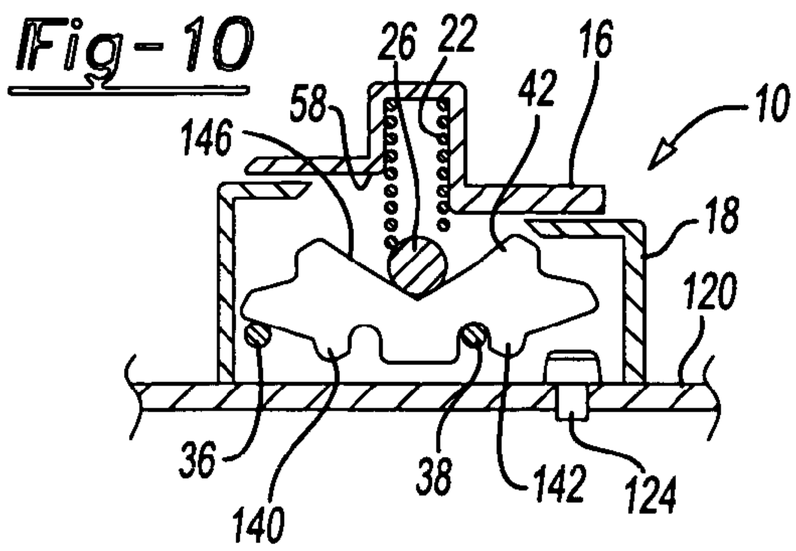

Fig-10

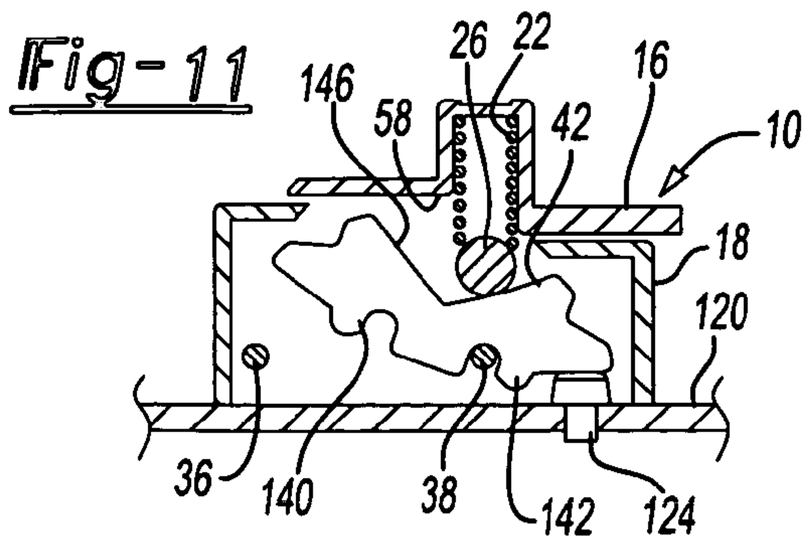

Fig-11

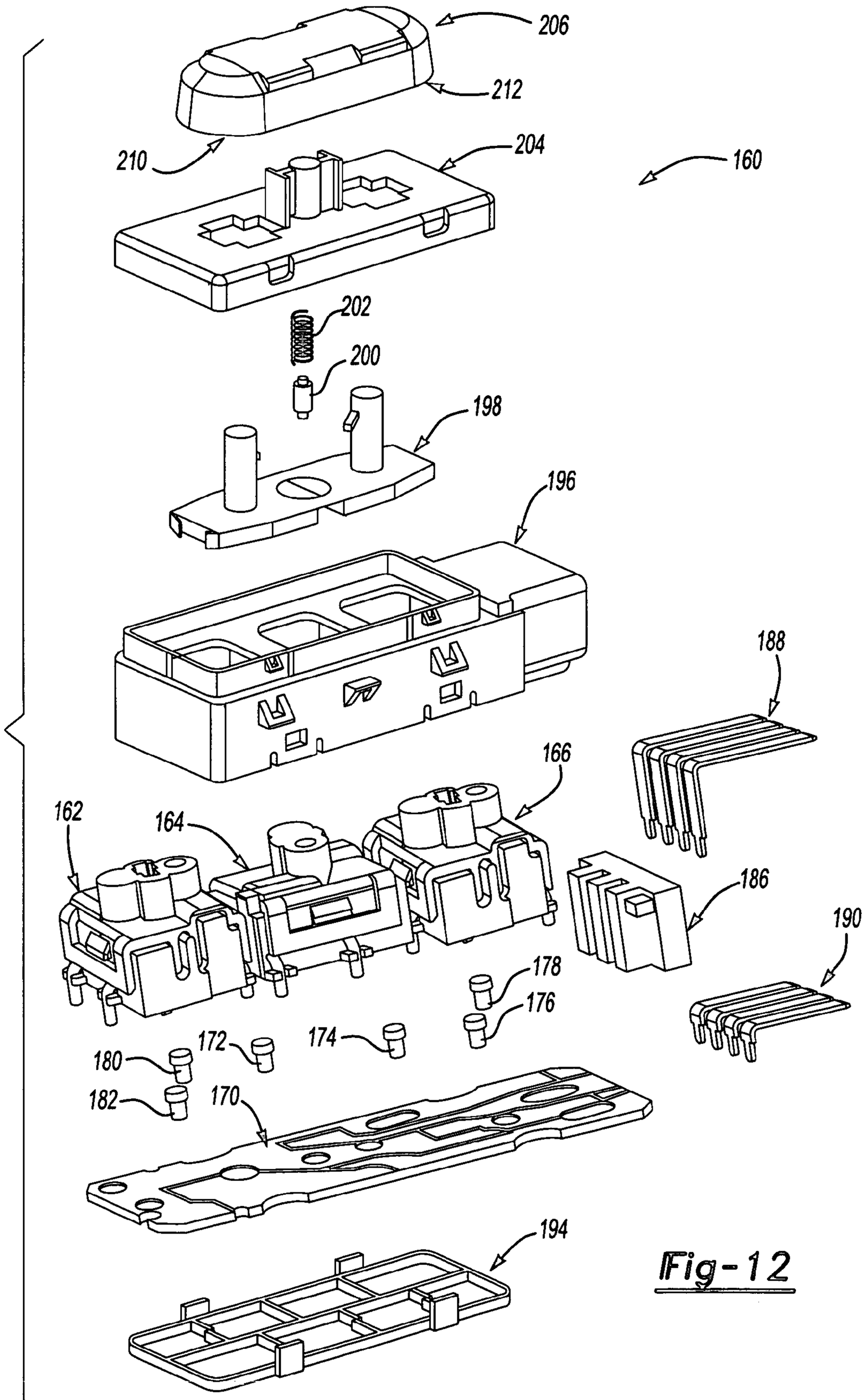
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Fig-12

SWITCH CELL

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to switch cells of the type having capabilities for opening and closing one or more electrical connections.

2. Background Art

A switch cell is an electrical device for opening and closing electrical connections. In general, the switch cell includes a top portion and a bottom portion, which are commonly referred to as an actuator and a base, respectively. The base includes contactors, and in some cases, other features for establishing an electrical connection, and the actuator includes an engagement arm, and in some cases other features, for actuating the contactor, such as for opening and closing an electrical connection.

The actuator and base are in some cases separately assembly such that the two halves are joined with a snap-fit or other engagement arrangement. This can be problematic as the components, such as the contactors and engagement arm, tend to be difficult to position when assembling the two halves. As such, what is needed is an improved switch cell that ameliorates the assembly problems associated with joining the two halves of the switch cell.

SUMMARY OF THE INVENTION

One aspect of the present invention relates to a switch cell. The switch cell preferably includes an actuator slidable engaged to a base such that the actuator is slidable between a first position and a second position. Preferably, one or more electrically conducting legs and an electrically conducting contactor are positioned within the base. One or more of the legs preferably retain the conductor in the base such that the actuator may be disengaged and the base held upside down without the contactor falling through a topside of the base. In the first position, the contactor preferably contacts the first and second legs for closing a first electrical connection therebetween. Still further, an engagement portion is preferably mounted to the actuator for moving the first contactor to open the electrical connection between the first and second leg if the actuator is in the second position. In this manner, the switch cell is able to open and close electrical connections and is configured to facilitate ease of assembly as the contactors are retained within the base, such as to permit the base to be inverted without the contactors falling out therefrom.

One aspect of the present invention relates to a multiple cell switch. The switch preferably includes at least three switch cells. Each switch cell preferably includes an actuator slidable engaged to a base between a first position and a second position, electrically conducting legs positioned within the base, and electrically conducting contactors positioned within the base through an underside thereof and retained therein with at least one of the legs such that the actuators may be disengaged and the bases held upside down without the contactors falling through a topside of the base. The contactors are preferably movable by the actuator to open and close electrical connections. The switch preferably includes a 10-way positionable knob in communication with the actuators to control the opening and closing of the electrical connections.

One aspect of the present invention a method of assembling a switch cell. The method preferably includes providing a base having an underside and a topside. The topside and underside preferably each have openings with the topside opening being smaller than the bottom side opening. The method preferably includes inserting an electrically conducting contactor through the underside opening in the base and at least one electrically conducting leg through a side of the base to retain the contactor therein. The electrical contactor is preferably smaller than the underside opening and larger than the topside opening such that the actuator may be held upside down without the first contactor falling through a topside of the base. The method preferably includes engaging an actuator to the base such that the actuator is slidable moveable relative to the base for moving the contactors, the movement of the contactors controlling opening and closing of electrical connections.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** illustrates an assembly view of a switch cell in accordance with one aspect of the present invention;

FIG. **2** illustrates an actuator in accordance with one aspect of the present invention;

FIGS. **3** and **4** illustrate a base in accordance with one aspect of the present invention;

FIG. **5** illustrates the assembled switch cell in more detail;

FIGS. **6–11** illustrate operation of the switch cell in accordance with one aspect of the present invention; and

FIG. **12** illustrates a multiple cell switch in accordance with one aspect of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT(S)

FIG. **1** illustrates an assembly view of a switch cell **10** in accordance with one aspect of the present invention. The switch cell **10** includes an actuator **16**, a base **18**, a pair of vertically orientated springs **20**, **22** and ball bearings **24**, **26**, a horizontally orientated spring **30**, a number of electrically conducting legs **32**, **34**, **36**, **38**, and a pair of electrically conducting contactors **40**, **42**.

In general, the contactors **40**, **42** are actuated by the actuator **16** to open and close electrical connections as described below in more detail. The switch cell **10** may be used in high and low current environments where it is desirable to open and close electrical connections. The switch cell **10** is particularly advantageous in high current, DC environments where arcing and other high current phenomena may occur, such as with vehicle seating where switching of high DC current is used to control a seat positioning motor. The present invention, however, is not intended to be limited to any particular environment and contemplates that the switch cell may be used in any environment or system and may include more or less of the above-identified features.

FIG. **2** illustrates the actuator **16** in accordance with one aspect of the present invention. As shown, the actuator **16** includes three channels **50**, **52**, **54** and a pair of engagement arms **56**, **58** in two of the three channels **50**, **54**. The engagement arms **56**, **58** receive the springs **20**, **22** and ball bearings **24**, **26** through an underside of the actuator **16**. In one aspect of the present invention, the springs **20**, **22** and ball bearings **24**, **26** are not retained within the engagement arms **56**, **58** such that they may fall out from the underside of the actuator **16**. As such, the actuator **16** is preferably flipped upside down, inverted, or rotated 180° from the right-side up orientation shown in FIG. **2**, so that the springs **20**, **22** and ball bearings **24**, **26** may be positioned within the actuator **16** and retained therein by gravity. The present

invention, however, does contemplate that a retainer or other feature may be included for retaining the springs **20**, **22** and ball bearings **24**, **26**.

The actuator **16** may further include the horizontally aligned spring **30** in the second channel. The second channel **52** preferably includes an enlarged portion **59** for receiving the spring **30** and locating it within a central portion of the channel **52**. As described below in more detail, the spring **30** biases against the base **18** to return the actuator **16** to a neutral, or first position, when force is removed therefrom.

The actuator **18** may further include a tower portion **60** and a pair of side slots **62**, **64**. The tower portion **60** may be used in actuation and to interact with other features connected thereto and it may include any number of shapes and features. The side slots **62**, **64** combine with features on the base **18** to engage it thereto for slidable movement therewith. The length of the side slide **62**, **64** defines a length of lateral movement for the actuator relative to the base.

FIGS. **3** and **4** illustrate the base **18** in accordance with one aspect of the present invention. As shown, the base **18** includes a pair of channels **70**, **72**, a pair of openings **76**, **78**, a number of caps **80**, **82**, **84**, **86**, a central rail **88**, and a number of snap fittings **90**, **92**, **94**, **96**. An underside of the base **18** includes a pair of openings **100**, **102** and a pair of locating pins **104**, **106**.

The contactors **40**, **42** are positioned through the openings **100**, **102** in the underside of the base **18** and secured therein with the legs **32**–**36**. In more detail, one or more contactors **40**, **42** are inserted through corresponding openings **100**, **102** and then one or more legs **32**–**36** are inserted through side openings in the base **16** and snapped thereto with the snapped fittings **90**–**96**. A portion of the legs **32**–**36** project through the side openings and under the contactor **40**, **42**. The caps **80**–**86** on the topside of the base cover a portion of the openings **100**, **102** shown on the underside. The combination of the legs **32**–**36** on the underside and the caps **80**–**86** of the top side retain the contactors **40**, **42** within the base **18** such that the contactors **40**, **42** are retained in the base **18** when it is upright, and if the base **18** is inverted, the caps **80**–**86** prevent the contactors **40**, **42** from falling through the topside of the base **18**.

Advantageously, once the one or more legs **34**–**36** are inserted, the contactors **40**, **42** are secured within the base **18** to facilitate ease of assembly. In particular, the base **18** is assembled to the actuator **16** by turning the actuator **16** upside down, so as to prevent the springs **20**, **22** and bearings **24**, **26** from falling out the underside of the actuator **16**, and the base **18** is turned upside down so that tabs **108**, **110** on the base **18** may be inserted into the actuator slide slots **60**, **62**. The engagement of the base **18** and actuator **16** in this manner permits the actuator **16** to slidable engage the base **18**.

The horizontally orientated spring **30** is positioned between tabs **114**, **116** of the central rail **88** such that axial movement of the actuator **16** compresses the spring **30**. In this manner, when force is removed, the actuator **16** returns to the first position.

FIG. **5** illustrates the assembled switch cell **10** in more detail. As shown, the actuator **16** covers slightly less than all of the topside of the base **18**. This is advantageous because it limits the overall length of the switch cell **10**, thus decreasing package and footprint size. The size of the actuator **16** may be correlated with the size of the caps **80**–**86** on the top side of the base **18** so that the actuator **16** may move laterally without exposing openings **76**, **78** in the top side of the base **18** such that the contactors **40**, **42** are protected from contaminates and other debris.

FIGS. **6**–**11** illustrate operation of the switch cell **10** in accordance with one aspect of the present invention. In particular, the operation of the switch cell **10** is illustrated with the switch cell being soldered to or otherwise connected to a printed circuit board (PCB) **120** having an electrically conducting legs or battery pins (B+) **122**, **124**. FIGS. **6**–**8** illustrate operation of the first contactor **40** from a cross-section view taken along line **6**—**6**. FIGS. **9**–**11** illustrate operation of the second contactor **42** from a cross-section view taken along line **9**—**9**.

FIG. **7** illustrates the first contactor **42** with the actuator **16** in a first position. In this position, a first side **126** and a second side **128** of a bottom edge of the contactor **42** rests on the first and second legs **32**, **34** that were previously inserted into the base **18** as described above. As such, the electrical conductivity of the contactor **40** and the legs **32**, **34** permit a first electrical connection to be established therebetween. As shown, the engagement arm **56** is positioned on an upper surface of a ramped profile portion **136** of the contactor. This first position is preferably a resting position of the actuator **16** to which the spring **30** returns it to when no force is applied thereto.

FIG. **10** illustrates the second contactor **42** with the actuator **16** in the first position. In this position, a first side **140** and a second side **142** of a bottom edge of the contactor **42** rests on the third and fourth legs **36**, **38** that were previously inserted into the base **18** as described above. As such, the electrical conductivity of the contactor **42** and the legs **36**, **38** permits a second electrical connection to be established therebetween. As shown, the engagement arm **58** is positioned on an upper surface of a ramped profile portion **146** of the contactor **42**.

FIG. **8** illustrates the first contactor **40** with the actuator **18** in a second position. In this position, the contactor **40** rests on the first and second legs **32**, **34**, and because of the positioning of the legs **32**, **34**, the contactor **40** maintains the first electrical connection therebetween. The spring **20** and ball bearing **24** have moved vertically with respect to FIG. **7** due to the ramped profile of the contactor **40**. The caps **80**, **82** protect the contactor **40** from exposure if the actuator **16** is moved to the second position, so as to limit the likelihood of contaminations and other debris from reaching the contactor **40** through the opening **76**.

FIG. **11** illustrates the second contactor **42** with the actuator **16** in the second position. In this position, the contactor **42** has pivoted about the fourth leg **38** such that the second side **142** of the contactor **42** is positioned proximate a bottom portion of the base **18**. Advantageously, this positioning may be used in combination with the element on the PCB **124**, such a first one of the B+ pins, to establish a third electrical connection between the third pin and the B+ pin **124**.

As also shown, the base **18** expands proximate the first side **140** of the contactor **42** to provide clearance for the rotating contactor **42**. The spring **22** and ball bearing **26** have moved vertically with respect to FIG. **10** due to the ramped profile of the contactor **42**. In particular, the caps **84**, **86** protects the contactor **42** from exposure if the actuator **16** is moved to the second position, so as to limit the likelihood of contaminations and other debris from reach the contactor **42** through the opening **78**.

FIG. **6** illustrates the first contactor **40** with the actuator **16** in a third position. In this position, the contactor **40** has pivoted about the first leg **32** such that the first side **126** of the contactor **40** is positioned proximate a bottom portion of the base **18**. Advantageously, this positioning may be used in combination with the element **122** on the PCB, such as a

second one of the B+ pins, to establish a fourth electrical connection between the first pin **32** and the B+ pin **122**.

As also shown, the base **18** expands proximate the second side **128** of the contactor to provide clearance for the rotating contactor **40**. The spring **20** and ball bearing **24** have moved vertically with respect to FIG. **7** due to the ramped profile of the contactor **40**. In particular, the caps **80**, **82** protect the contactor **40** from exposure if the actuator **16** is moved to the third position, so as to limit the likelihood of contaminations and other debris from reach the contactor **40** through the opening **76**.

FIG. **9** illustrates the second contactor **42** with the actuator **16** in the third position. In this position, the contactor **42** rests on the third and fourth legs **36**, **38**, and because of the positioning of the legs **36**, **38**, the contactor maintains the second electrical connection therebetween. The spring **22** and ball bearing **26** have moved vertically with respect to FIG. **10** due to the ramped profile of the contactor **42**. The caps **84**, **86** protect the contactor **42** from exposure if the actuator **16** is moved to the third position, so as to limit the likelihood of contaminations and other debris from reaching the contactor **42** through the opening **78**.

As described above, the first and second contactors **40**, **42** are moveable to open and close electrical connections. In particular, the first contactor **40** is moveable to open and close an electrical connection between the first and second legs **32**, **36** and another electrical connection between the first leg **32** and an element **122** on the PCB. Likewise, the second contactor **42** is moveable to open and close an electrical connection between the third and fourth legs **36**, **38** and another electrical connection between the fourth leg **38** and an element **124** on the PCB. The dual contactors **40**, **42** described above provide dual functionality in a single switch cell **10** in so far as only one actuator **16** is required to provide multiple connections. Of course, however, the present invention is not limited to dual contactors. Rather, more or less contactors may be included in the switch cell.

FIG. **12** illustrates a multiple cell switch **160** in accordance with one aspect of the present invention. The multiple cell switch **160** includes a first **162**, second **164**, and third **166** switch cells, of the type described above, to open and close multiple electrical connections on a PCB **170**.

In accordance with one aspect of the present invention, cells **162**, **164**, **166** are orientated in various configurations such that each contactor included therein may be used to provide an electrical connection with a feature on the PCB, such as a number of electrically conducting legs **172–182** shown in FIG. **10**. Preferably, the multiple cell switch **160** is a seat switch for operating a seat positioning motor and the features on the PCB are battery power (B+) pins that conduct high DC current.

The multiple cell switch **160** includes an insulator **186** and a pair of blades **188**, **190** connected to the PCB **170**. The insulator **186** connects to a power-source or other feature (not shown) for providing electrical connection to the PCB **170** and the blades **188**, **190** provide the electrical connections therewith. The multiple cell switch **160** further includes a cover **194**, a housing **196**, a slide plate **198**, a plunger **200**, a spring **202**, a backplate **204**, and a knob **206**.

The cover **194** affixes to a bottom side of the PCB **170**, such as to affix the switch **160** within a vehicle or other location. The housing **196** covers the PCB **170** and the cells **162–166** thereon, such as to protect them from damage and contamination. The slide plate **198**, plunger **200**, spring **202**, backplate **204**, and knob **206** operation cooperatively for moving the actuators on each cell. The spring **202** and plunger **200** provide a tactile feel and the knob **206** is moveable in ten directions to open and close the electrical connections of each cell.

In accordance with one aspect of the present invention, the knob **206** is moveable axially to open and close electrical connections of the second cell **164**. A forward portion **210** of the knob **206** is moveable laterally to open and close electrical connections of the first cell **162**. A rearward portion **212** of the knob **206** is moveable laterally to open and close electrical connections of the third cell **166**. The entire knob **206**, i.e. both the forward and rearward portions **210**, **212**, is moveable laterally to simultaneously open and close electrical connections of the first and third cells **162**, **166**. The knob **206** may be rotate or twisted to open and close electrical connections of the first and third cells **162**, **166**. In this manner, the multiple switch cell **160** provides 10-way switching functionality.

While embodiments of the invention have been illustrated and described, it is not intended that these embodiments illustrate and describe all possible forms of the invention. Rather, the words used in the specification are words of description rather than limitation, and it is understood that various changes may be made without departing from the spirit and scope of the invention.

What is claimed is:

1. A switch cell, the switch cell comprising:

an actuator slidable engaged to a base, the actuator slidable between a first position and a second position;

first and second electrically conducting legs positioned within at least a portion of the base;

a first electrically conducting contactor positioned within at least a portion of the base through an underside thereof and retained therein with at least one of the first and second legs such that the actuator may be disengaged and the base held upside down without the first contactor falling through a topside of the base, the first contactor contacting the first and second legs in the first position for closing a first electrical connection therebetween; and

an engagement portion of the actuator for moving the first contactor to open the electrical connection between the first and second leg if the actuator is in the second position.

2. The switch cell of claim **1** wherein the first contactor includes an upper edge having a ramped profile along which the engagement portion travels to pivot the first contactor with movement of the actuator from the first position to the second position, thereby opening the first electrical connection between the first and second leg.

3. The switch cell of claim **2** wherein the first contactor includes a bottom edge having a first side proximate the second leg in the first position to provide the first electrical connection between the first leg and the second leg and a second side proximate a bottom portion of the base, the ramped profile of the first contactor causing the first side to pivot away from the second leg and the second side to pivot toward the bottom portion of the base if the actuator is moved from the first position to the second position so as to open the first electrical connection between the first side and the second leg such that the second side may contact a third electrically conducting leg proximate the bottom portion of the base to provide an second electrical connection between the third and first legs.

4. The switch cell of claim **3** wherein the third leg is separate from the base, such as on a printed circuit board.

5. The switch cell of claim **1** further comprising a first spring positioned within the base and in communication

with the actuator to bias the actuator to the first position such that the actuator returns to the first position from the second position if force is removed therefrom.

6. The switch cell of claim **1** wherein the engagement portion comprises a ball bearing a spring positioned within the actuator through an underside thereof such that the actuator is held upside down to retain the spring and ball bearing therein and the base is held upside down for engagement to the actuator.

7. The switch cell of claim **1** further comprising:

fourth and fifth electrically conducting legs positioned within the base; and

a second electrically conducting contactor positioned within the base through an underside thereof and retained therein with at least one of the fourth and fifth legs such that the actuator may be disengaged and the base held upside down without the second contactor falling through the topside of the base, the second contactor contacting the fourth and fifth legs in the first and second positions for closing a third electrical connection therebetween.

8. The switch cell of claim **7** wherein the actuator is slidable to a third position such that in the third position the engagement portion moves the second contactor to open the third electrical connection between the fourth and fifth legs and to close the first electrical connection of the first contactor between the first and second legs.

9. The switch cell of claim **8** wherein the second contactor includes an upper edge having a ramped profile along which the engagement portion travels to pivot the second contactor with movement of the actuator from the first or second positions to the third position, thereby opening the third electrical connection between the fourth and fifth leg.

10. The switch cell of claim **9** wherein the second contactor includes a bottom edge having a first side proximate the fifth leg in the first and second positions to provide the third electrical connection between the fourth and fifth legs and a second side proximate a bottom portion of the base, the ramped profile of the second contactor causing the first side to pivot away from the fifth leg and the second side to pivot toward the bottom portion of the base if the actuator is moved from the first or second positions to the third position so as to open the third electrical connection between the first side and the fifth leg such that the second side may contact a sixth electrically conducting leg proximate the bottom portion of the base to provide a fourth electrical connection between the sixth and fourth legs.

11. The switch cell of claim **1** wherein the topside of the base includes a cap over at least a portion of the contactor to prevent the contactor from falling through the topside if the base is turned upside down when the actuator is disengaged.

12. The switch cell of claim **11** wherein the actuator covers a portion of the topside of the base between the cap and the contactor to limit particulates from contaminating the contactors.

13. The switch cell of claim **12** wherein the actuator is sufficiently sized to cover the contactor in the first and second positions.

14. A multiple cell switch, the switch comprising:

at least three switch cells, each switch cell having:

an actuator slidable engaged to a base, the actuator slidable between a first position and a second position;

electrically conducting legs positioned within at least a portion of the base; and

electrically conducting contactors positioned within the base through an underside thereof and retained therein with at least one of the legs such that the actuators may be disengaged and the bases held upside down without the contactors falling through a topside of the base, the contactors movable by the actuator to open and close electrical connections; and

a 10-way positionable knob in communication with the actuators to control the opening and closing of the electrical connections.

15. The switch of claim **14** wherein each contactor pivots about one of the legs that retains the contactors in the base such that pivoting controls the opening and closing of the electrical connections.

16. The switch of claim **14** wherein a topside of the bases includes a cap over at least a portion of the contactor to prevent the contactor from falling through the topside if the base is turned upside down when the actuator is disengaged.

17. The switch of claim **14** wherein each cell is mounted on a printed circuit board and each cell includes four electrically conducting legs for conducting with the printed circuit board and the printed circuit board includes two electrically conducting features for conducting with the contactors of each cell if the contactors are pivot to a position proximate a bottom side of each base.

18. A method of assembling a switch cell, the method comprising:

providing a base, the base having an underside and a topside each having an opening, the topside opening being smaller than the bottom side opening;

inserting an electrically conducting contactor through the underside opening in the base, the electrical conductor smaller than the underside opening and larger than the topside opening;

inserting at least one electrically conducting leg through a side of the base to retain the contactor therein with at least one of the first and second legs such that the actuator may be held upside down without the first contactor falling through a topside of the base; and

engaging an actuator to the base such that the actuator is slidable moveable relative to the base for moving the contactors, the movement of the contactors controlling opening and closing of electrical connections.

19. The method of claim **18** further comprising inserting a spring and ball bearing through an underside of the actuator, the spring and ball bearing being in communication with the contactor when the actuator is engage to control movement of the contactors, the spring and ball bearing being unrestrained in the actuator such that spring and ball bearing fall from the underside of the actuator if the actuator is held upright.

20. The method of claim **18** further comprising inverting the actuator after insertion of the spring and ball bearing to retain the spring and ball bearing therein and inverting the base such that the base and actuator are engaged in the inverted positions.

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